

1 WHAT IS CLAIMED IS:

1. A mapping catheter comprising:

an elongated tubular catheter body having an outer wall, proximal and distal ends, and at least one lumen extending therethrough; and

5 a mapping assembly comprising:

a tubular structure having a generally straight proximal region attached to the catheter body, a generally circular main region generally transverse and distal to the proximal region having an outer circumference, a transition region connecting the proximal region and the main region, and a generally straight distal region distal the main region and extending

10 substantially tangentially from the main region, wherein the tubular structure comprises a non-conductive cover over at least the main region of the mapping assembly,

a support member having shape-memory disposed within at least the main region of the mapping assembly; and

15 a plurality of spaced-apart electrodes carried by the generally circular main region of the mapping assembly.

2. A catheter according to claim 1, further comprising an intermediate section between the catheter body and the mapping assembly, the intermediate section having at least one lumen extending therethrough and being more flexible than the catheter body.

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3. A catheter according to claim 2, wherein the intermediate section has three lumens extending therethrough.

4. A catheter according to claim 1, wherein the generally circular main region has an outer diameter ranging from about 10 mm to about 25 mm.

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5. A catheter according to claim 1, wherein the generally circular main region has an outer diameter ranging from about 10 mm to about 25 mm.

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1           6.     A catheter according to claim 1, wherein the generally circular main region has an outer diameter of about 15 mm.

5           7.     A catheter according to claim 1, wherein the transition region is slightly curved and formed such that, when viewed from the side of the catheter with the proximal region at the top of the circular main region, the proximal region forms an angle  $\alpha$  with the circular region ranging from about 75° to about 95°.

10          8.     A catheter according to claim 1, wherein the transition region is slightly curved and formed such that, when viewed from the side of the catheter with the proximal region at the top of the circular main region, the proximal region forms an angle  $\alpha$  with the circular main region ranging from about 83° to about 93°.

15          9.     A catheter according to claim 1, wherein the number of electrodes along the generally circular main region ranges from about 6 to about 20.

          10.    A catheter according to claim 1, wherein the number of electrodes along the generally circular main region ranges from about 8 to about 12.

20          11.    A catheter according to claim 1, wherein the electrodes are approximately evenly spaced around the generally circular main region.

          12.    A catheter according to claim 1, wherein the generally straight proximal region has an exposed length ranging from about 3 mm to about 12 mm.

25          13.    A catheter according to claim 1, wherein the generally straight proximal region has an exposed length ranging from about 3 mm to about 8 mm.

30          14.    A catheter according to claim 1, wherein the generally straight distal region has an atraumatic design to prevent the distal end of the mapping assembly from penetrating tissue.

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15. A catheter according to claim 1, wherein the generally straight distal region has a length ranging from about 0.25 inch to about 1.0 inch.

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16. A catheter according to claim 2, further comprising a control handle mounted at the proximal end of the catheter body and means for deflecting the intermediate section by manipulation of the control handle.

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17. A catheter according to claim 16, wherein the control handle comprises a first member fixedly attached to the proximal end of the catheter body and a second member that is movable relative to the first member.

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18. A catheter according to claim 17, wherein the deflecting means comprises a puller wire having a proximal end and a distal end, the puller wire extending from the control handle, through the catheter body and into a lumen in the intermediate section, wherein the distal end of the puller wire is fixedly secured within the intermediate section and the proximal end of the puller wire is fixedly secured to the second member of the control handle, whereby manipulation of the first member of the control handle relative to the second member of the control handle moves the puller wire relative to the catheter body, resulting in deflection of the intermediate section.

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19. A mapping catheter comprising:

an elongated tubular catheter body having an outer wall, proximal and distal ends, and at least one lumen extending therethrough; and

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a mapping assembly comprising:

a tubular structure comprising a generally circular main region generally transverse and distal to the catheter body and having an outer circumference and a generally straight distal region distal to the main region extending substantially tangentially from the generally circular main region and generally transversally to the catheter body, wherein the

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1 tubular structure comprises a non-conductive cover over at least the main region of the mapping assembly;

a support member having shape-memory disposed within at least the main region of the mapping assembly; and

5 at least one electrode carried by the generally circular main region of the mapping assembly.

20. A catheter according to claim 19, wherein the mapping assembly further comprises a generally straight proximal region attached to the catheter body and a transition  
10 region connecting the proximal region and the main region.

21. A catheter according to claim 19, wherein the mapping assembly comprises a plurality of electrodes carried by the generally circular main region of the mapping assembly, wherein the electrodes are generally evenly spaced about the entire circumference of the  
15 mapping assembly such that, in use, when the mapping assembly is positioned in a tubular region of or near the heart, with the outer circumference of the generally circular main region in contact with the inner circumference of the tubular region, the electrodes can be used to map the inner circumference of the tubular region.

20 22. A catheter according to claim 19, wherein the generally circular main region has an outer diameter ranging from about 10 mm to about 25 mm.

23. A catheter according to claim 19, wherein the generally circular main region has an outer diameter ranging from about 12 mm to about 20mm.

25 24. A catheter according to claim 19, wherein the number of electrodes along the generally circular main region ranges from about 6 to about 20.

25. A catheter according to claim 19, wherein the number of electrodes along the  
30 generally circular main region ranges from about 8 to about 12.

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26. A catheter according to claim 19, wherein the generally straight distal region has an atraumatic design to prevent the distal end of the mapping assembly from penetrating tissue.

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27. A catheter according to claim 19, further comprising means for deflecting the distal end of the catheter body without altering the shape of the mapping assembly.

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28. A catheter according to claim 27, wherein the deflecting means comprises:  
a puller wire extending through a lumen of the catheter body, said puller wire being  
fixedly attached at its distal end to the catheter body near the catheter body's distal end; and  
a control handle for moving the puller wire longitudinally relative to the catheter body to  
thereby cause deflection of the distal end of the catheter body.

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29. A catheter according to claim 19, wherein the distal region is more flexible than the main region.

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30. A mapping catheter comprising:  
an elongated tubular catheter body having an outer wall, proximal and distal ends, and at  
least one lumen extending therethrough;  
a mapping assembly comprising:

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a tubular structure having a generally circular main region generally transverse  
and distal to the catheter body having an outer circumference, and a generally straight distal  
region distal to the main region extending substantially tangentially from the generally circular  
main region, wherein the tubular structure comprises a non-conductive cover over at least the  
main region of the mapping assembly;

a support member having shape-memory disposed within at least the main region  
of the mapping assembly; and

at least one electrode carried by the generally circular main region of the mapping  
assembly; and

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1 means for deflecting the distal end of the catheter body without altering the shape of the mapping assembly.

31. A catheter according to claim 30, wherein the deflecting means comprises:  
5 a puller wire extending through a lumen of the catheter body, said puller wire being fixedly attached at its distal end to the catheter body near the catheter body's distal end; and a control handle for moving the puller longitudinally relative to the catheter body to thereby cause deflection of the distal end of the catheter body.

10 32. A catheter according to claim 30, wherein the generally circular main region has an outer diameter ranging from about 10 mm to about 25 mm.

33. A catheter according to claim 30, wherein the generally circular main region has an outer diameter ranging from about 12 mm to about 20 mm.

15 34. A catheter according to claim 30, wherein the number of electrodes along the generally circular main region ranges from about 8 to about 12.

35. A catheter according to claim 30, wherein the mapping assembly comprises a  
20 plurality of electrodes carried by the generally circular main region of the mapping assembly, wherein the electrodes are generally evenly spaced about the entire circumference of the mapping assembly such that, in use, when the mapping assembly is positioned in a tubular region of or near the heart, with the outer circumference of the generally circular main region in contact with the inner circumference of the tubular region, the electrodes can be used to map the inner  
25 circumference of the tubular region.

36. A catheter comprising:  
an elongated flexible tubular catheter body having an axis and proximal and distal ends;  
a mapping assembly at the distal end of the tubular body having a preformed generally  
30 circular curve having an outer surface and being generally transverse to the axis of the catheter

1 body, the mapping assembly also having a proximal end, and a generally straight distal end distal  
to the generally circular curve and extending substantially tangentially therefrom, the mapping  
assembly carrying a plurality of spaced apart electrodes;

an electrode lead wire associated with each electrode, each electrode lead wire having  
5 proximal and distal ends and extending through the catheter body and into the mapping  
assembly, the distal end of each electrode lead wire being electrically connected to its associated  
electrode;

a puller wire having proximal and distal ends extending through the tubular catheter  
body, the distal end of the puller wire being fixedly attached to the distal end of the catheter  
10 body; and

a handle connected to the proximal ends of the catheter body and puller wire for moving  
the puller wire longitudinally relative to the catheter body, whereby longitudinal movement of  
the puller wire relative to the catheter body results in deflection of the distal end of the catheter  
body.

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37. A catheter according to claim 36, wherein the electrodes carried by the generally  
circular curve are generally evenly spaced about the generally circular curve of the mapping  
assembly, such that, in use, when the generally circular curve is positioned in a tubular region of  
or near the heart, with the outer surface of the generally circular curve in contact with the inner  
20 circumference of the tubular region, the electrodes can be used to map the inner circumference of  
the tubular region.

38. A catheter according to claim 36, wherein the generally circular curve has an  
outer diameter ranging from about 10 mm to about 25 mm.

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39. A catheter according to claim 36, wherein the generally circular curve has an  
outer diameter ranging from about 12 mm to about 20 mm.

40. A catheter according to claim 36, wherein the distal region is more flexible than  
30 the generally circular curve.

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41. A mapping catheter comprising:

an elongated flexible tubular catheter body having an axis and proximal and distal ends;

a mapping assembly at the distal end of the tubular body comprising a compound curve

5 having a first bend away from the axis of the catheter body and a second bend having a preformed generally circular curve transverse to the axis of the catheter body, said mapping assembly having a proximal end, and a generally straight distal end extending substantially tangentially from the generally circular curve and generally transversally to the axis of the catheter body, the mapping assembly carrying a plurality of spaced apart electrodes;

10 an electrode lead wire associated with each electrode, each electrode lead wire having proximal and distal ends and extending through the catheter body and into the mapping assembly, the distal end of each electrode lead wire being electrically connected to its associated electrode;

15 a puller wire having proximal and distal ends extending through the tubular catheter body, the distal end of the puller wire being fixedly attached to the distal end of the catheter body; and

20 a handle connected to the proximal ends of the catheter body and puller wire for moving the puller wire longitudinally relative to the catheter body, whereby longitudinal movement of the puller wire relative to the catheter body results in deflection of the distal end of the catheter body.

42. A catheter according to claim 41, wherein the compound curve has an outer diameter ranging from about 10 mm to about 25 mm.

25 43. A catheter according to claim 41, wherein the compound curve has an outer diameter ranging from about 12 mm to about 20 mm.

44. A catheter according to claim 41, wherein the number of electrodes on the mapping assembly ranges from about 8 to about 12.

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1           45.     A catheter according to claim 41, wherein the distal region is more flexible than  
the compound curve.

5           46.     A catheter according to claim 41, wherein the generally straight distal region is  
more flexible than the compound curve.

          47.     A mapping catheter comprising:  
an elongated tubular catheter body having an outer wall, proximal and distal ends, and at  
least one lumen extending therethrough; and

10           a mapping assembly comprising:  
a tubular structure comprising a generally circular main region generally  
transverse and distal to the catheter body and having an outer circumference and a generally  
straight distal region distal to the main region extending substantially tangentially from the  
generally circular main region, the distal region being more flexible than the generally circular  
15 main region, wherein the tubular structure comprises a non-conductive cover over at least the  
main region of the mapping assembly;

          a support member having shape memory disposed within at least the main region  
of the mapping assembly; and

          at least one electrode carried by the generally circular main region of the mapping  
20 assembly.

          48.     A catheter according to claim 47, wherein the mapping assembly further  
comprises a generally straight proximal region attached to the catheter body and a transition  
region connecting the proximal region and the main region.

25           49.     A catheter according to claim 47, wherein the generally circular main region has  
an outer diameter ranging from about 10 mm to about 25 mm.

          50.     A catheter according to claim 47, wherein the generally circular main region has  
30 an outer diameter ranging from about 12 mm to about 20 mm.

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51. A catheter according to claim 47, wherein the number of electrodes along the generally circular main region ranges from about 8 to about 12.

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52. A mapping catheter comprising:

an elongated tubular catheter body having an outer wall, proximal and distal end, and at least one lumen extending therethrough; and

a mapping assembly comprising:

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a tubular structure comprising a generally circular main region generally transverse and distal to the catheter body and having an outer circumference and a diameter ranging from about 10 mm to about 25 mm, and a generally straight distal region distal the main region extending substantially tangentially relative to the generally circular main region, wherein the tubular structure comprises a non-conductive cover over at least the main region of the mapping assembly;

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a support member having shape memory disposed within at least the main region of the mapping assembly;

a plurality of electrodes carried by the generally circular main region of the mapping assembly; and

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a plurality of electrode lead wires, each electrode lead wire having a distal end electrically connected to a corresponding electrode on the generally circular main region and a proximal end electrically connected to a suitable monitoring apparatus.

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53. A catheter according to claim 52, wherein the generally circular main region has an outer diameter ranging from about 12 mm to about 20 mm.

54. A catheter according to claim 52, wherein the number of electrodes along the generally circular main region ranges from about 8 to about 12.

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55. A catheter according to claim 52, wherein the distal region is more flexible than the main region.

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56. A mapping catheter comprising:

an elongated tubular catheter body having an outer wall, proximal and distal ends, and at least one lumen extending therethrough; and

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a mapping assembly comprising:

a tubular structure comprising a generally circular main region generally transverse and distal to the catheter body and having an outer circumference and a diameter ranging from about 10 mm to about 25 mm, and a generally straight distal region distal to the main region extending substantially tangentially relative to the generally circular main region;

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a plurality of electrodes carried by the generally circular main region of the mapping assembly; and

a plurality of electrode lead wires, each electrode lead wire having a distal end electrically connected to a corresponding electrode on the generally circular main region.

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57. A catheter according to claim 56, wherein, when the catheter is viewed from the side with the catheter body positioned at the top of the generally circular main region, the catheter body forms an angle with the generally circular main region ranging from about 75° to about 95°.

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58. A catheter according to claim 56, wherein, when the catheter is viewed from the side with the catheter body positioned at the top of the generally circular main region, the catheter body forms an angle with the generally circular main region ranging from about 83° to about 93°.

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59. A catheter according to claim 56, wherein the generally circular main region has an outer diameter ranging from about 12 mm to about 20 mm.

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60. A catheter according to claim 56, wherein, when the catheter is viewed from the side with the catheter body positioned at the top of the generally circular main region, the

- 1 catheter body forms an angle with the generally circular main region ranging from about 75° to about 95°.

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